

THE WEATHER AND CIRCULATION OF OCTOBER 1970

Marked Persistence From September

A. JAMES WAGNER

National Meteorological Center, National Weather Service, NOAA, Suitland, Md.

1. MEAN CIRCULATION

Generally low heights at high latitudes with monthly mean 700-mb Low centers over northeast Siberia and slightly to the North American side of the Pole combined with a northward-displaced Pacific subtropical High to produce flat, faster than normal westerly flow over the North Pacific (figs. 1 and 2). Monthly mean wind speeds were greater than 15 m s^{-1} and as much as 7 m s^{-1} above normal near Kamchatka (fig. 3).

In contrast to the previous month (Taubensee 1970), the westerlies over the central Atlantic decreased as 700-mb heights increased to more than 100 m above normal over northeast Canada (fig. 2). This represented a height anomaly change of as much as 140 m from September to October (fig. 4). A branch of the westerlies penetrated to low latitudes in the central Atlantic (fig. 1) where several slow-moving tropical and subtropical disturbances contributed to a pronounced monthly mean negative anomaly center 50 m below normal (fig. 2).

Related to the onset of blocking over eastern North America was a further deepening and sharpening of the trough in the Great Plains where heights fell to 50 m below normal (figs. 2 and 4). With the exception of this region and western Russia, where there was also a deeper than normal full-latitude trough, the Northern Hemisphere 700-mb jet stream was north of its normal October position (fig. 3).

2. TEMPERATURE

The temperature anomaly pattern for October (fig. 5) showed little change from September (Taubensee 1970) except that lower than normal averages pushed farther eastward in the central and southern portions of the Nation. This is in good agreement with the area of maximum height anomaly fall from the previous month (fig. 4). The persistent nature of the anomaly pattern is also shown by the fact that 41 of 100 selected stations over the conterminous United States remained in the same temperature anomaly class (out of five possible categories) from September to October. This was about twice the number that would have been expected by chance.

The magnitude of the positive temperature anomalies over the East decreased somewhat since above-normal 700-mb heights associated with subsidence centered over the mid-Atlantic area in September (fig. 2 of Taubensee 1970) were replaced by an anomalous easterly component of maritime flow during October (fig. 2). Increased cloudiness and moisture reduced daytime maximum temperatures, although minima remained considerably

above normal due to unfavorable conditions for nocturnal radiational cooling. A number of more protected locations in the mid-Atlantic and Southeastern States did not have a killing frost by the end of the month, thus extending the growing season several weeks later than normal.

Although there were no new monthly mean temperature records established for warmth, several stations in the western half of the Nation had record or near-record cold during October (table 1). It was the second consecutive record-breaking cold month at Pendleton, Ore.

3. PRECIPITATION

The precipitation distribution over the Nation displayed some persistence from September to October, although not as much as the temperature pattern, with 40 out of 100 stations remaining within the same class (out of three), seven more than the number expected by chance. Heaviest totals were in the South where a large area had more than twice the normal amount of rainfall (fig. 6). Portions of Texas, Louisiana, and Mississippi recorded more than four times normal precipitation, and several new records were set (table 2).

Another area with totals in excess of twice normal was the northern Mississippi Valley where several stations reported near-record totals. These areas of heavy precipitation were related to the frequent storms generated in the persistent trough in the middle of the country. Instead of moving northeastward along the usual St. Lawrence Valley track, these disturbances were deflected on an abnormal northward path by the strong blocking over eastern Canada. Some of the heavy precipitation in the Southeast was due to anomalous easterly flow bringing in tropical air from the Atlantic.

The principal dry areas were in the Southwest where precipitation was less than half normal (fig. 6). Other smaller areas of deficient precipitation were located over Montana, Florida, and the Middle Atlantic States. Although not quite up to normal, the rains were especially welcome in California where they eased the critical fire danger situation over the northern half of the State. Up until October 18 when the rains began, Red Bluff, Calif., had recorded only 1.43 in. of precipitation in the preceding 221 days, and unparalleled drought at that location.

Some of the precipitation fell as snow over the central and western portions of the Nation. An early fall snowstorm swept through the central plains on October 8 and 9, setting many records for early season and October snowfall (table 3).

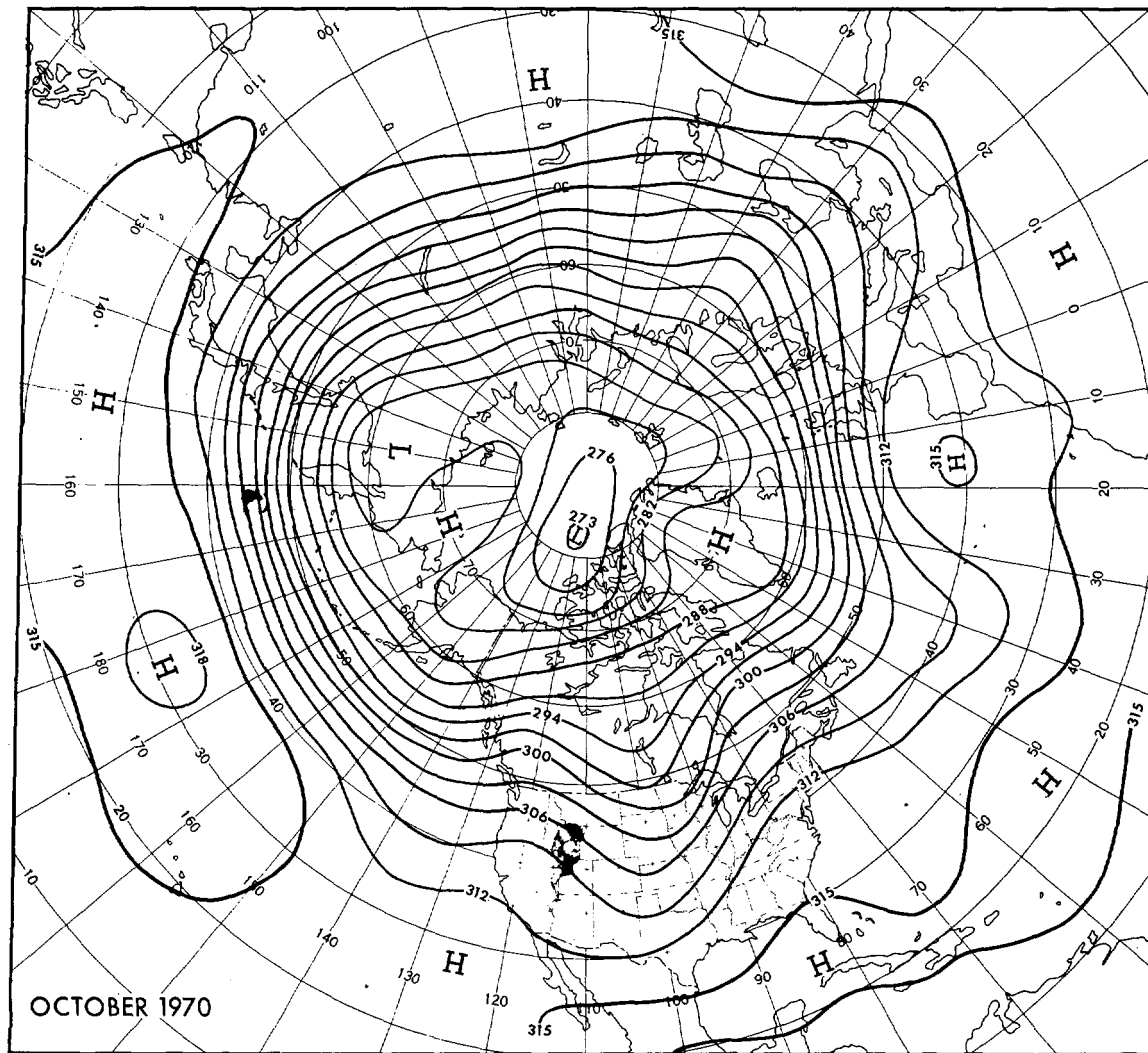


FIGURE 1.—Mean 700-mb contours (decameters) for October 1970.

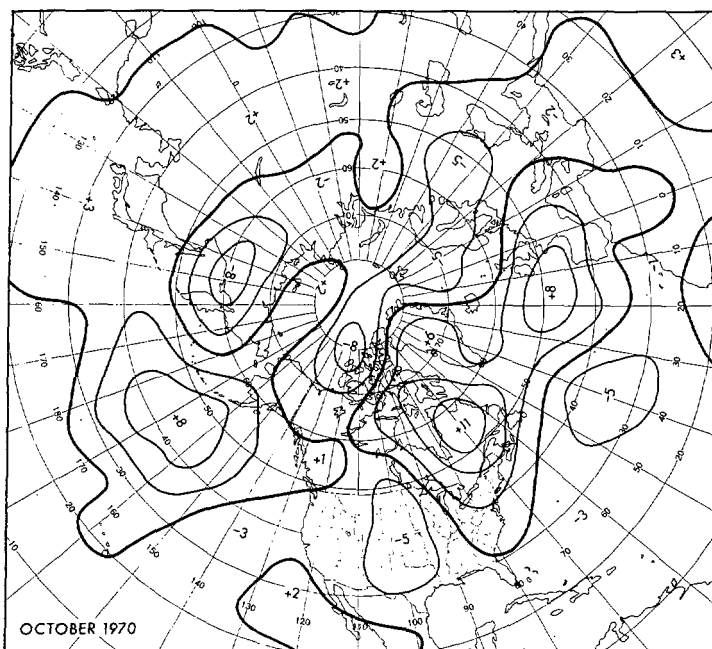


FIGURE 2.—Departure from normal of mean 700-mb height (decameters) for October 1970.

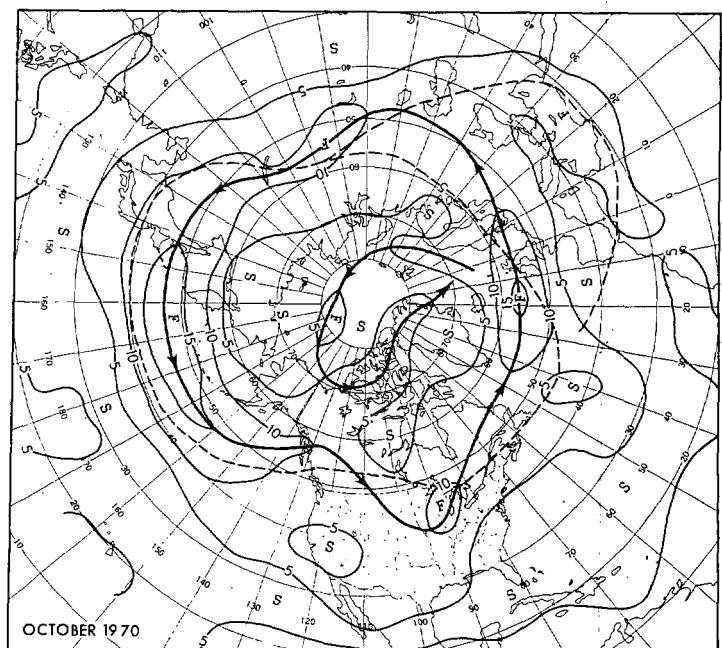


FIGURE 3.—Mean 700-mb isotachs (meters per second) for October 1970. Heavy arrows indicate principal axes of maximum wind speed; dashed lines, the normal.

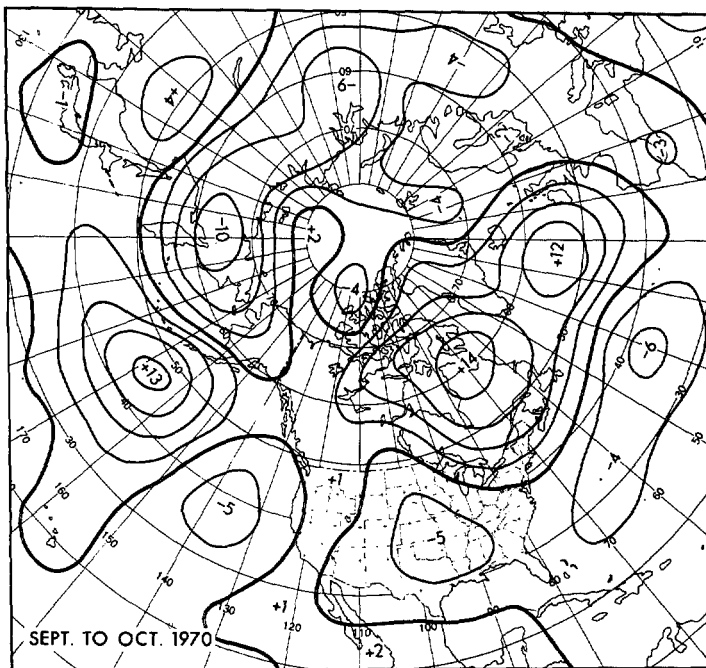


FIGURE 4.—Mean 700-mb height anomaly change (decimeters) from September to October 1970.

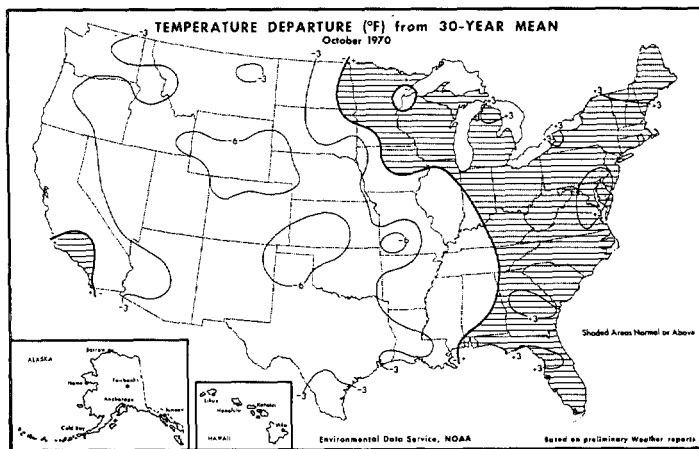


FIGURE 5.—Departure from normal of average surface temperature (°F) for October 1970 (from Environmental Data Service and Statistical Reporting Service 1970).

4. VARIABILITY WITHIN THE MONTH

For convenience, the month may be divided into halves. The first few days of October, however, were untypical of most of the month. A warm ridge over the Northwest and troughs moving through the Great Lakes area gave predominantly dry conditions except over the Northeast and Arizona and New Mexico. In the latter area, a cut-off Low gave rainfall totals in excess of an inch at some of the normally dry desert stations. Late-season records for warmth were equaled or exceeded at several locations in Oregon and Montana (table 4) while temperatures were lower than normal over the eastern half of the Nation.

TABLE 1.—Record and near-record monthly mean temperatures for October 1970

Station	Monthly mean (°F)	Departure (°F)	Remarks
El Paso, Tex.	58.5	-4.9	Coldest Oct. on record
Norfolk, Nebr.	47.9	-5.0	2d coldest Oct. in 45 yr
North Platte, Nebr.	45.4	-5.6	3d coldest Oct. on record
Casper, Wyo.	41.2	-7.1	3d coldest Oct. on record
Kalispell, Mont.	38.1	-4.8	4th coldest Oct. since 1899
Pendleton, Oreg.	47.4	-6.3	Coldest Oct. at airport location
Olympia, Wash.	36.6	Lowest avg. Oct. minimum on record
San Francisco, Calif.	64.3	Lowest avg. Oct. maximum on record
Tucson, Ariz.	65.1	-4.9	Coldest Oct. since 1920

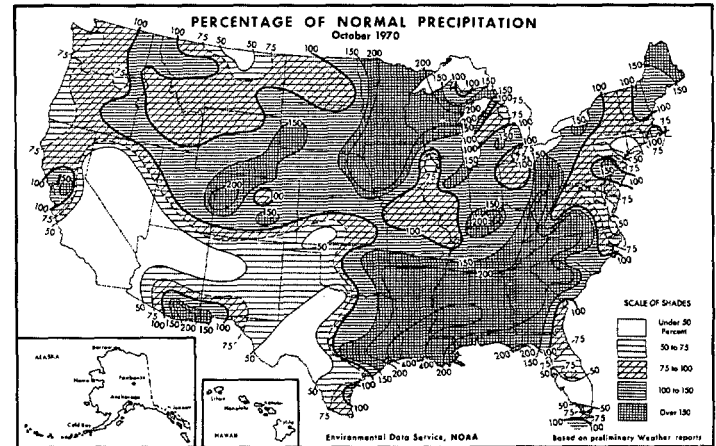


FIGURE 6.—Percentage of normal precipitation for October 1970 (from Environmental Data Service and Statistical Reporting Service 1970).

TABLE 2.—Record and near-record monthly precipitation totals for October 1970

Station	Total (inches)	Departure (inches)	Remarks
Port Arthur, Tex.	15.09	+12.21	Wettest Oct. on record
Meridian, Miss.	10.65	+ 8.43	Wettest Oct. on record
Jackson, Miss.	9.13	+ 7.09	4th wettest Oct. on record
Birmingham, Ala.	7.04	+ 4.09	2d wettest Oct. on record
Sioux City, Iowa	4.57	+ 3.15	2d wettest Oct. on record
Rochester, Minn.	6.08	+ 4.38	2d wettest Oct. on record
St. Cloud, Minn.	5.10	+ 3.46	3d wettest Oct. on record
Parkersburg, W. Va.	5.83	+ 3.78	3d wettest Oct. since 1888

The circulation for the first half of October featured strong ridges just off the east and west coasts of North America and a deep full-latitude trough extending from central Canada to Texas (fig. 7). An intense polar Low was located over the Canadian Archipelago, with a strong High just over the Siberian side of the Pole.

The week of October 5-11 brought sharp drops in temperature over the western half of the Nation as the October regime became established. Temperatures plunged from the summery 80s to freezing and below in just a few days as a sharp trough moved inland and formed a

TABLE 3.—Record and near-record snowfall during October 1970

Station	Amount (inches)	Date	Remarks
Pueblo, Colo.	6.3	-----	4th heaviest Oct. total
Dodge City, Kans.	1.1	8	Earliest measurable snow
Topeka, Kans.	0.8	9	Earliest measurable snow
Concordia, Kans.	4.6	9	Earliest measurable snow and heaviest Oct. total
Grand Island, Nebr.	0.1	8	Earliest measurable snow
Lincoln, Nebr.	6.6	9	Earliest measurable snow
Lincoln, Nebr.	5	9	Greatest depth on ground for Oct.
Omaha, Nebr.	3.1	9	Earliest measurable snow
Sioux City, Iowa	5.1	9	Earliest snowfall of 1 in. or more and 3d heaviest Oct. total
Sioux Falls, S. Dak.	5.1	-----	Heaviest Oct. total since 1925
Huron, S. Dak.	5.0	9	Heaviest so early in season
Huron, S. Dak.	5.3	-----	3d heaviest Oct. total
Avoca, Pa.	0.3	17	Most so early in season
Fairbanks, Alaska	21.9	-----	3d heaviest monthly total in 40 yr

TABLE 4.—Record high and low temperatures during October 1970

Station	Temperature (°F)	Date	Remarks
Salem, Oreg.	93	2	Highest so late in season and highest for the month
Astoria, Oreg.	81	2	Equalled highest so late in season
Portland, Oreg.	90	2	Highest so late in season
Eugene, Oreg.	88	2	Highest so late in season
Missoula, Mont.	83	4	Highest so late in season
Great Falls, Mont.	19	7	Lowest so early in season
Medford, Oreg.	27	8	Lowest so early in season
Casper, Wyo.	12	8	Lowest so early in season
Rapid City, S. Dak.	16	8	Lowest so early in season
Amarillo, Tex.	28	9	Lowest so early in season
Lubbock, Tex.	29	9	Lowest so early in season
Concord, N.H.	17	20	Equalled lowest so early in season
Providence, R.I.	23	20	Lowest so early in season
Ely, Nev.	3	27	Lowest so early in season and lowest for the month
Millford, Utah	8	28	2d lowest in Oct. in 63 yr
Winslow, Ariz.	13	28	Lowest for the month
El Paso, Tex.	25	29	Lowest so early in season and lowest for the month

cut-off center over the central Rockies. This was associated with the record early snowstorm in the Great Plains and new temperature records for early season cold (tables 3 and 4).

The surface High that brought cool weather to the Eastern States the previous week was transformed into a slow-moving warm dynamic High as upper level heights rose strongly over the East in response to the amplification upstream.

For the week as a whole, temperatures ranged from as much as 15°F below normal in Wyoming to 9°F above normal over northern Maine. Heavy precipitation spread through the middle of the country in connection with storms moving along a slow-moving frontal zone (figs. 8A and 8B). No rain fell over the Southwest or the mid-Atlantic coastal region.

A slowly moving tropical depression caused disastrous floods in Puerto Rico where as much as 25 to 33 in. of

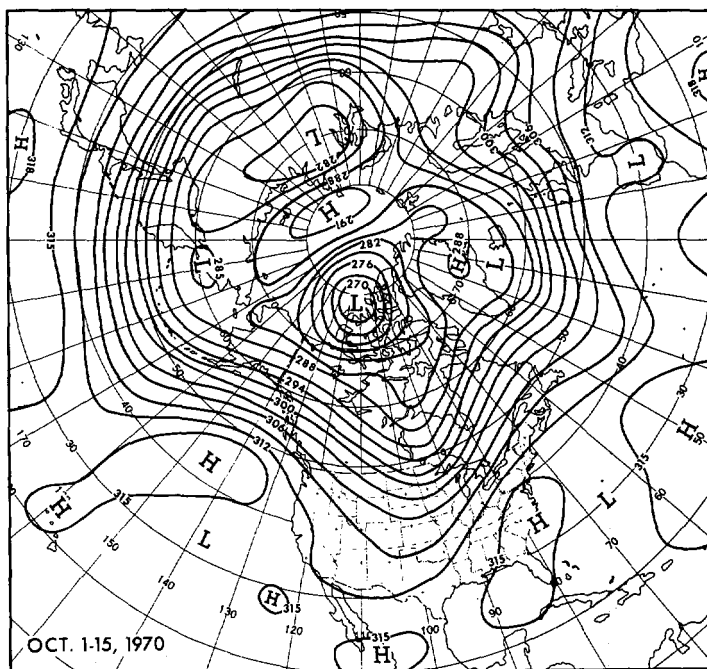


FIGURE 7.—Mean 700-mb. contours (decimeters) for Oct. 1-15, 1970.

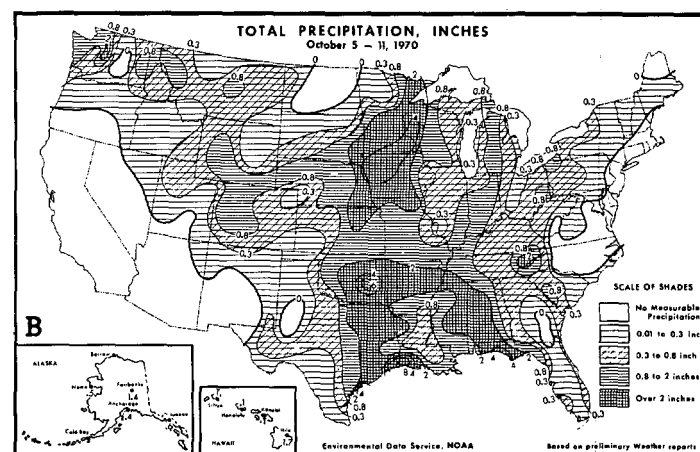
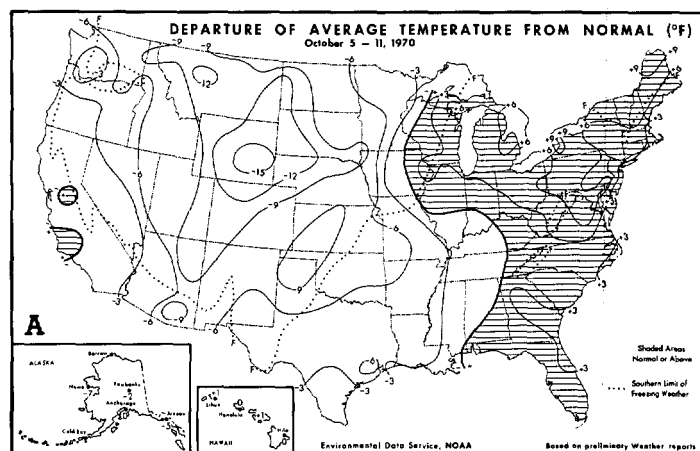


FIGURE 8.—(A) departure from normal of average surface temperature (°F) and (B) total precipitation (inches) for the week of Oct. 5-11, 1970 (from Environmental Data Service and Statistical Reporting Service 1970).

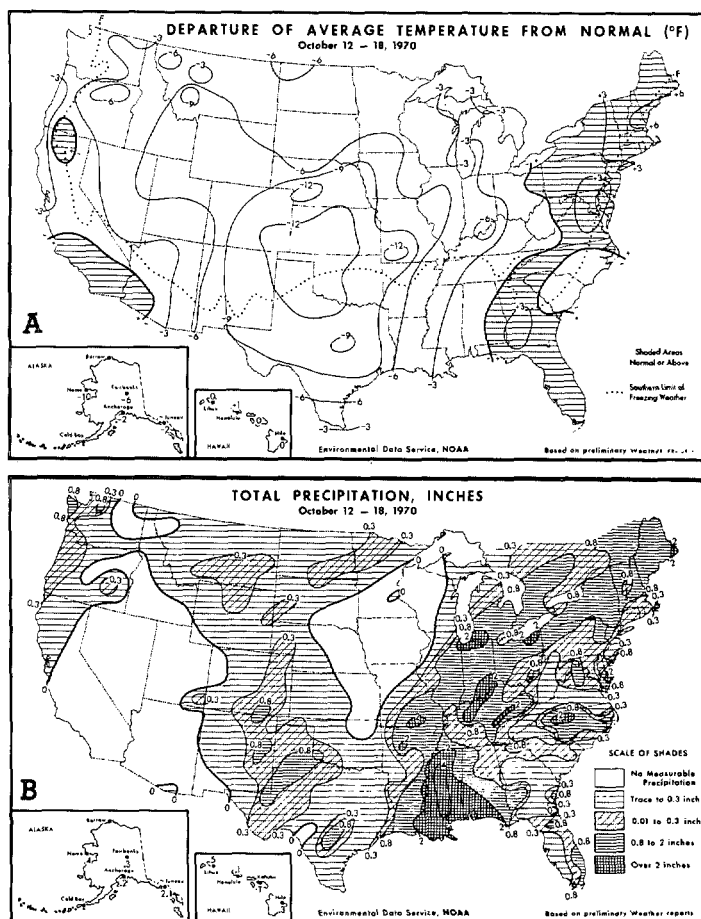


FIGURE 9.—Same as figure 8, for the week of Oct. 12–18, 1970.

rain fell in 5 consecutive days. Daily totals in excess of a foot were measured; and crops, bridges, and property were extensively damaged.

During the week of October 12–18, successive surges of cold air pushed farther eastward until by the end of the week the main polar front was off the east coast with a brief return of ridge conditions to the Northwest. Except for the Atlantic Coast States and portions of California, the entire country had below-normal temperatures, with greatest negative anomalies of more than -12°F over the southern and central plains (fig. 9A).

Precipitation was more equitably distributed with the northern Mississippi Valley temporarily drying out, and most other areas except for the Southwest reporting some precipitation (fig. 9B). The first snow of the season fell in northern New York State and northern New England toward the end of the week, with some localities measuring up to 10 in.

Just after the middle of the month, the circulation at middle and high latitudes of the Northern Hemisphere changed radically. In response to amplification and progression over the western Pacific, a deep trough developed over the eastern Pacific, replacing the strong ridge that prevailed during the first half of October. Half-monthly mean 700-mb heights fell by as much as 290 m (fig. 10), and the remains of the ridge moved east to central Canada

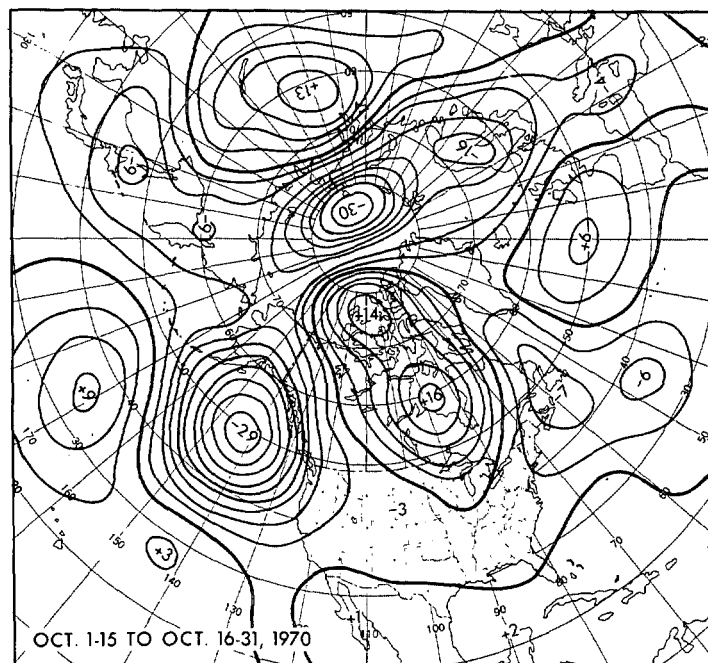


FIGURE 10.—Change in half-monthly mean 700-mb height (decameters) between Oct. 1–15 and 16–31, 1970.

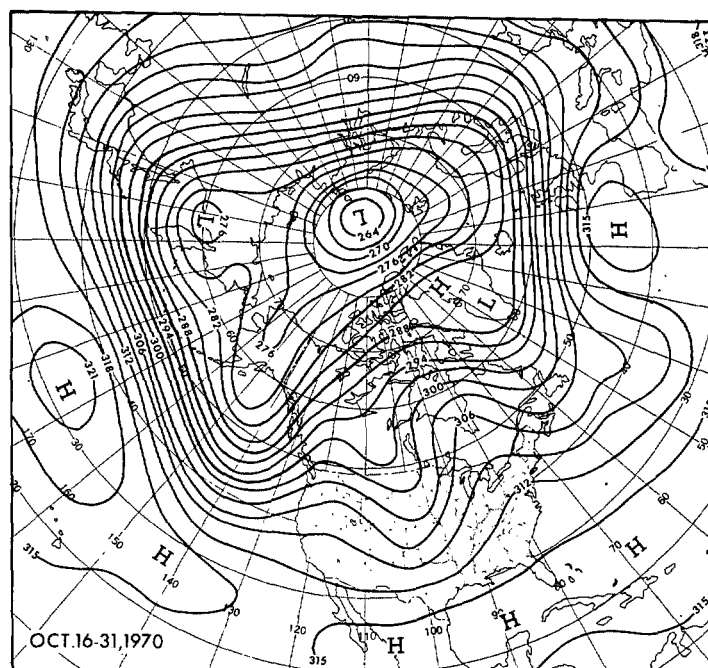


FIGURE 11.—Mean 700-mb contours (decameters) for Oct. 16–31, 1970.

(fig. 11), in effect bringing about a discontinuous retrogression of the northern portions of the ridge that had been over the eastern North American coast during the first half of the month (fig. 7).

The downstream response to these developments was the retrogression of the northern portions of the central Atlantic trough, building of a strong ridge west of Spain,

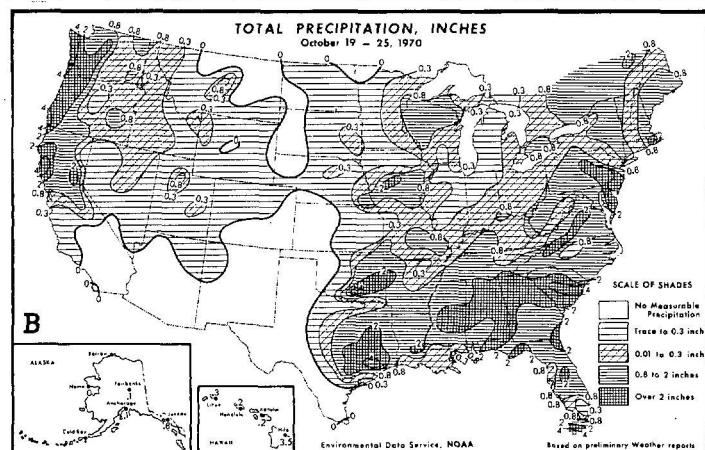
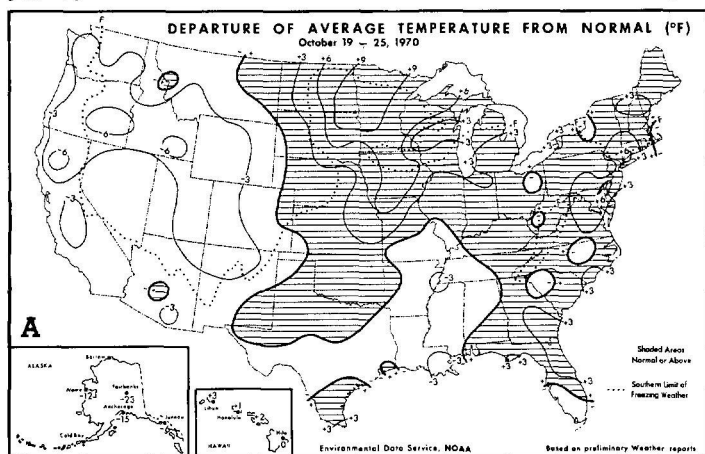


FIGURE 12.—Same as figure 8, for the week of Oct. 19–25, 1970.

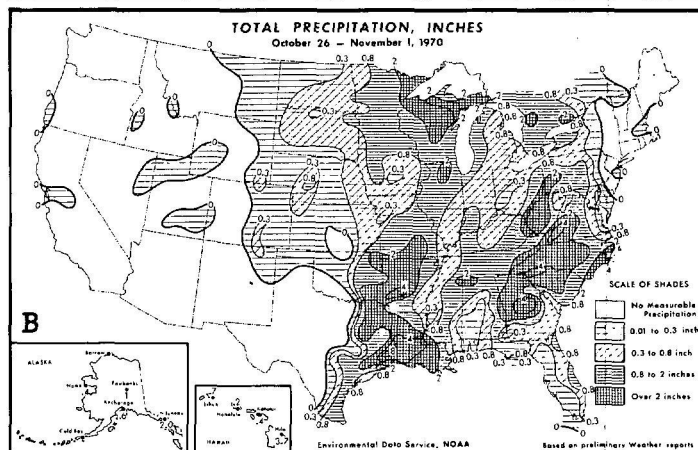
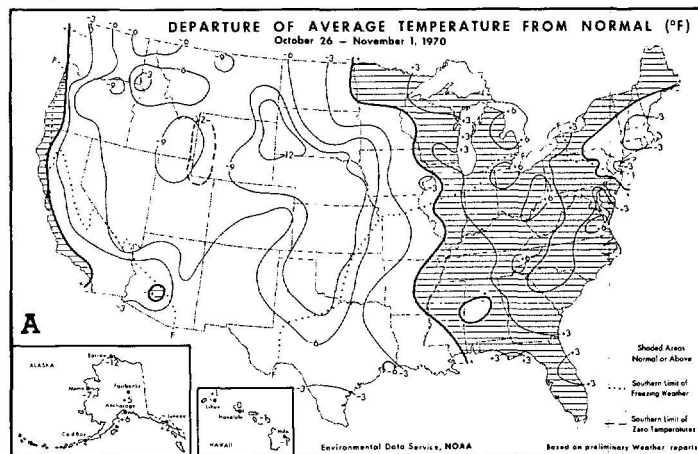


FIGURE 13.—Same as figure 8, for the week of Oct. 26–Nov. 1, 1970.

and deepening of a broad trough associated with much storminess over Europe (fig. 11). At high latitudes, the polar Low remained intense and crossed to the Asian side where 700-mb heights fell by as much as 300 m from the first to the second half of October (fig. 10). Height rises over northern Siberia were associated with the amplification and progression over the Pacific.

Midmonth changes in 700-mb mean heights were smaller over the United States. Most significant for the weather were the rises north of the Great Lakes associated with retrogression of the blocking ridge, and falls off the west coast resulting in more southerly components in the flow and the onset of the rainy season in that area (fig. 10).

In response to the retrogression of the Canadian ridge, temperatures warmed considerably over the Great Lakes and northern Mississippi Valley during the week of October 19–25. The southern limit of freezing for the week extended almost to the Canadian border in North Dakota, quite unusual for so late in the season (fig. 12A), while it remained mild over the East and on the cool side over the western third of the Nation.

Precipitation was fairly well distributed over most of the country, with heaviest amounts in parts of the South and along the Pacific coast from northern California to Washington (fig. 12B). One of the storms that hit the Northwest created winds near hurricane force along the

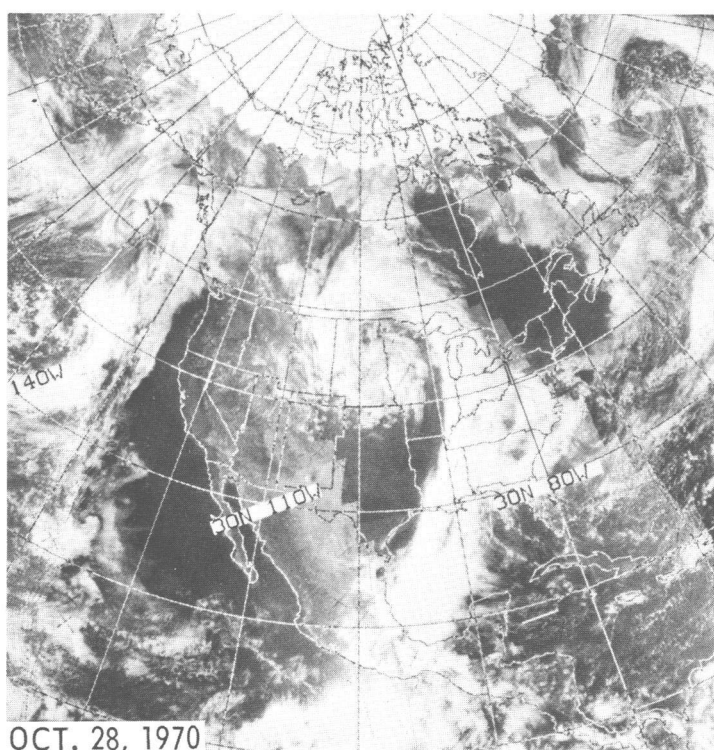


FIGURE 14.—Cloud distribution as photographed by ITOS 1 satellite on Oct. 28, 1970.

coast and increased snow depths to over 30 in. in some of the inland mountains.

As the blocking strengthened further over central Canada, a large intense cut-off Low formed north of Montana as a trough moved inland from the Pacific. This system had progressed only as far as Minnesota by the end of the week and spawned several northward-moving storms in the middle of the country.

During the last week of October, the weather was quite mild over the Midwest; temperatures ranged up to 6°F above normal in the Ohio Valley and Great Lakes (fig. 13A). Once again, the cold over the West strengthened with negative anomalies up to -12°F as strong radiational cooling was favored under the ridge when skies cleared. Some sections of the Great Plains received more snow from the series of storms in the middle of the country, and this aided the cooling. A number of stations in the Southwest established new records for the early season and October cold (table 4).

Heaviest precipitation was along the Mississippi Valley storm belt (fig. 13B), and excessive rains occurred in east-

ern Texas and Louisiana where some funnel clouds and tornadoes were also observed. The ITOS 1 satellite photo of North America (fig. 14) on October 28 shows the broad cloud circulation pattern of the great storm system that produced this weather. Although surface pressure failed to fall below 1004 mb, the storm had a very marked solid moisture band extending from the Gulf of Mexico to Canada and also had the classical appearance of a mature occluding cyclone. Since the overall system moved so slowly, this daily picture was well related to the precipitation pattern for the whole week.

REFERENCES

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- Taubensee, Robert E., "The Weather and Circulation of September 1970—Warm in the East and Cool in the West With Heavy Precipitation in Many Central Areas," *Monthly Weather Review*, Vol. 98, No. 12, Dec. 1970, pp. 938-943.